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TRANSLATIONAL

Intentional Laceration of the Anterior Mitral Valve Leaflet to Prevent Left Ventricular Outflow Tract Obstruction During Transcatheter Mitral Valve Replacement

Pre-Clinical Findings

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ABSTRACT

OBJECTIVES The authors propose a novel transcatheter transection of the anterior mitral leaflet to prevent iatrogenic left ventricular outflow tract (LVOT) obstruction during transcatheter mitral valve replacement (TMVR).

BACKGROUND LVOT obstruction is a life-threatening complication of TMVR caused by septal displacement of the anterior mitral leaflet.

METHODS In vivo procedures in swine were guided by biplane x-ray fluoroscopy and intracardiac echocardiography. Retrograde transaortic 6-F guiding catheters straddled the anterior mitral leaflet. A stiff 0.014-inch guidewire with polymer jacket insulation was electrified and advanced from the LVOT, through the A2 leaflet base, into the left atrium. The wire was snared and externalized, forming a loop that was energized and withdrawn to lacerate the anterior mitral leaflet.

RESULTS The anterior mitral leaflet was successfully lacerated in 7 live and 1 post-mortem swine under heparinization. Lacerations extended to 89 ± 19% of leaflet length and were located within 0.5 ± 0.4 mm of leaflet centerline. The chordae were preserved and retracted the leaflet halves away from the LVOT. LVOT narrowing after benchtop TMVR was significantly reduced with intentional laceration of the anterior mitral leaflet to prevent LVOT obstruction than without (65 ± 10% vs. 31 ± 18% of pre-implantation diameter, $p < 0.01$). The technique caused mean blood pressure to fall (from 54 ± 6 mm Hg to 30 ± 4 mm Hg, $p < 0.01$), but blood pressure remained steady until planned euthanasia. No collateral tissue injury was identified on necropsy.

CONCLUSIONS Using simple catheter techniques, the anterior mitral valve leaflet was transected. Cautiously applied in patients, this strategy can prevent anterior mitral leaflet displacement and LVOT obstruction caused by TMVR.
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ABBREVIATIONS AND ACRONYMS

LAMPOON = laceration of the anterior mitral leaflet to prevent left ventricular outflow tract obstruction

LVOT = left ventricular outflow tract

TMVR = transcatheter mitral valve implantation

Transcatheter stent valves (both purpose-built and off-label) are implanted to relieve mitral valve failure—whether native, bioprosthetic, or after annuloplasty—when the risk for mitral valve surgery is prohibitive (1,2). These transcatheter mitral stent valves may cause acute left ventricular outflow tract (LVOT) obstruction by displacing the anterior mitral valve leaflet toward the septum. Formal criteria have not been established, but as in surgery (3,4), contributors to LVOT obstruction include angulated mitral and aortic annular planes, long or redundant anterior mitral leaflets, small ventricles, bulging septa, and narrow leaflet-to-septum distance (5–7). Preparatory or bailout transcoronary alcohol septal ablation can debulk the septum (8,9) but risks important myocardial and conduction system injury. Moreover, alcohol septal ablation is not feasible when septal thickness is normal and typically requires a delay of 4 to 6 weeks for remodeling before transcatheter mitral valve replacement (TMVR), in highly symptomatic patients. The anterior mitral leaflet can be resected during hybrid surgical TMVR but requires cardiopulmonary bypass (10). We propose a transcatheter alternative.

We describe a simple catheter technique to prevent LVOT obstruction by transecting the anterior mitral valve leaflet, called laceration of the anterior mitral leaflet to prevent LVOT obstruction (LAMPOON). The procedure uses an electrified guidewire that traverses the leaflet base, between 2 retrograde aortic catheters, and which then is pulled outward toward the leaflet tip (**Figures 1A and 1B**). The split anterior mitral leaflet no longer obstructs the LVOT after stent valve implantation and is displaced around the implant by intact chordae tendineae (**Figures 1C to 1F**). We developed and tested the technique in vivo and ex vivo in swine.

METHODS

LAMPOON TECHNIQUE. The technique has 2 steps: leaflet traversal followed by leaflet laceration (**Figure 2**). Traversal is intended to be performed before, and laceration after, positioning of the transcatheter mitral valve. This would allow rapid valve implantation during expected hemodynamic compromise from intended mitral leaflet laceration.

For leaflet traversal, dual retrograde 6-F guiding catheters (Vista Brite Tip, Cordis Corporation, Miami Lakes, Florida) were positioned using 0.035-inch guidewires, 1 into the left atrium, taking care to cross the main mitral orifice without chordal entanglement, and the other in the LVOT, abutting the aortomitral curtain. The LVOT catheter was positioned immediately below the hinge point of the aortomitral curtain, as confirmed by contrast angiography in a projection that corresponds to a 3-plane echocardiogram. Alignment along the center of the anterior leaflet, corresponding to the commissure between the left and noncoronary cusps of the aortic valve, was achieved using contrast angiography in a projection corresponding to a short-axis echocardiogram. Intracardiac echocardiography (AcuNav; Siemens Healthcare, Erlangen, Germany) confirmed this position. A closed-loop snare (10-mm Amplatz GooseNeck, Medtronic, Minneapolis, Minnesota) was positioned through the left atrial catheter behind the atrial base of the anterior mitral leaflet. Through the LVOT catheter, a stiff 0.014-inch guidewire (Astato XS 20, Asahi-Intecc, Nagoya, Japan) was extended through an electrically insulating 0.035-inch polymer jacket (Piggyback Wire Convertor 145 cm, Vascular Solutions, Minneapolis, Minnesota) and directed toward the snare. The proximal guidewire was connected via forceps to a monopolar electrosurgery pencil and diathermy generator (Valleylab Force FX, Medtronic, Minneapolis, Minnesota) set at 30-W continuous duty cycle (“cutting” mode). After traversal, the Piggyback polymer jacket was withdrawn, and the free end of the guidewire was externalized through the retrograde left atrial catheter, positioned to protect against inadvertent tissue injury. The result was a transcatheter guidewire loop around the anterior mitral valve leaflet. No traction was applied until the laceration procedure was initiated, to avoid causing or exacerbating mitral valve regurgitation. Correct traversal was confirmed by angiography through the LVOT catheter and by echocardiography.

Laceration entails traction on both ends of the guidewire that has crossed the leaflet base, during electrification. The intended result is longitudinal

heart valves. Dr. Babaliaros is a consultant for Edwards Lifesciences and Abbott Vascular; and his employer has research contracts for multicenter investigation of transcatheter aortic and mitral devices from Edwards Lifesciences, Abbott Vascular, Medtronic, St. Jude Medical, and Boston Scientific. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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